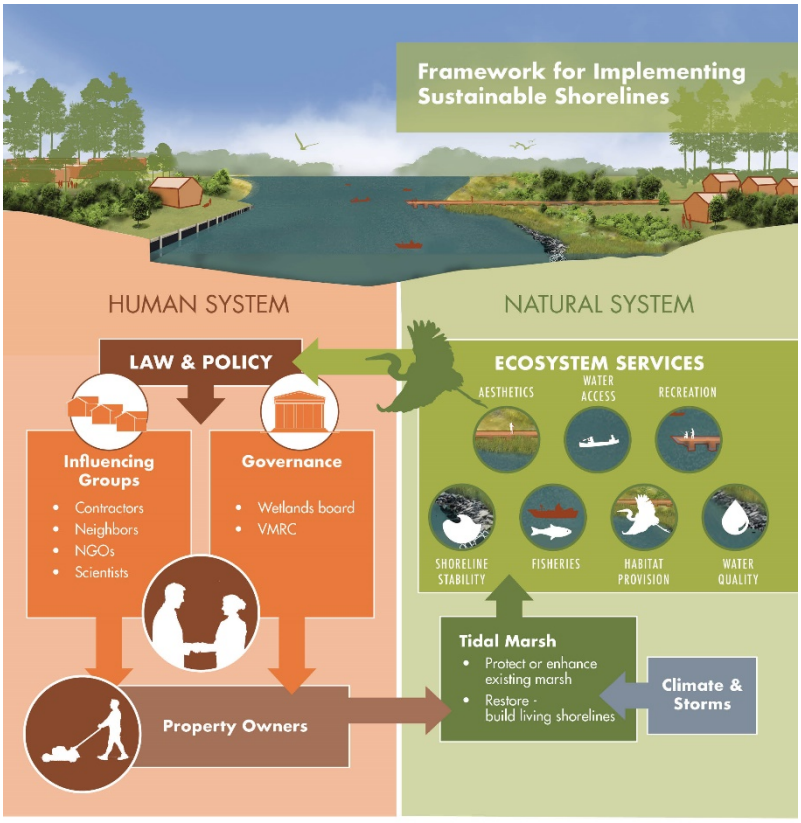
SUSTAINABILITY IN CHESAPEAKE BAY SHORESCAPES: CLIMATE CHANGE, MANAGEMENT DECISIONS, AND ECOLOGICAL FUNCTIONS

Worldwide, the integrity of salt marsh ecosystems and the ecosystem services that they provide to coastal communities has been compromised by shoreline hardening with structures like bulkheads, riprap revetment and seawalls to protect against property erosion. With rising seas and coastal development intensification, property owners will likely demand more shoreline protection. Natural and nature-based shoreline protection approaches – for our purposes, *living shorelines* – are being encouraged through various government policies as alternatives to armoring for several reasons. In addition to providing erosion control and storm protection, they, unlike structures such as bulkheads, can adapt to rising seas. They also provide numerous additional societal and ecosystem benefits, including carbon sequestration, water quality improvement, and critical habitat for fish, shellfish, and wildlife. These approaches include both conserving and restoring tidal marshes. Because much of the US coastline is privately owned, marsh sustainability along coasts and estuaries, such as Chesapeake Bay, will be greatly influenced by individual property owner decisions. We provide insights into the possible futures of Chesapeake Bay shorescapes under climate change and different shoreline management strategies, and identify social intervention points that may foster more sustainable shoreline decision making to enhance short- and long-term ecosystem service provisions and benefits.

GOAL: Characterize the Shorescape Social-Ecological System (SES) to determine what elements have the greatest influence on attainment of sustainable outcomes, namely maximizing ecosystem services in Virginia moving forward



Developed by the Virginia Institute of Marine Science at William and Mary for the National Science Foundation (NSF) Coastal Science, Engineering, and Education for Sustainability (SEES) Initiative.Image designed by Kelsey Broich, Network for Engineering with Nature, University of Georgia. (2021).

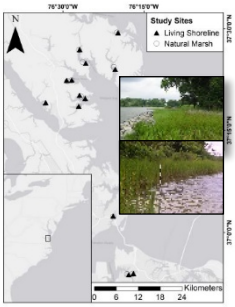
This cross-disciplinary project engaged social scientists, economists, sociologists, demographers, physical and geospatial modelers, ecologists, biogeochemists and legal scholars to apply an SES approach to describe the relative importance of various interactions between the **Bay system** (physical drivers of shoreline change), **shoreline resources** (*marshes and the ecosystem services they provide*), **law & policy** (*shoreline and marsh protection*), **resource users** (*property owners*), **influencing groups** (*nonprofits, neighbors, scientists, contractors*), and **governance of resource usage** (*local and state policy makers and resource managers*) to inform decision-making for sustainability and enhancement of ecosystem services.

APPROACH

HUMAN SYSTEM: Identify decision factors influencing both property owners & the policy/management personnel governing shoreline property owners

We used multiple approaches to assess why people decide to modify their shoreline and the type of shoreline modification they choose. We surveyed current property owners to determine the factors that impacted their decisions. We also surveyed multiple groups to assess their level of influence and role in property owner decisions, including local Wetlands Boards, state Tidal Wetland Regulators (VMRC), local NGOs, and marine contractors. We examined historic patterns of shoreline modification decisions using wetlands permit data combined with cadastral and environmental data to assess the primary factors driving decisions on different shoreline modifications (i.e., armor, living shoreline, or do nothing). We evaluated shore and marsh protection laws from Florida to Delaware for commonalities and variation in the characteristics of the law that drive trends in shoreline modification.

NATURAL SYSTEM: Determine the environmental consequence of changes in Bay shorescapes through a series of field investigations describing the ecological functions provided by natural fringing marsh shorelines and those provided by living shorelines marshes.



We evaluated the differences in proxies of ecosystem functions related to marsh ecosystem services: **1)** habitat provision (invertebrate, fish, bird, terrapin; abundance, biomass, diversity), **2)** primary production (aboveground plant biomass), nutrient storage (aboveground plant and soil total N, P content), and **3)** carbon storage (aboveground plant and soil carbon content) for both natural marshes and a chronosequence (2 to 16 years from construction) of living shorelines, within shorescapes representing the continuum of marsh connectivity conditions.

Shorescapes, *a shoreline zone which includes riparian, intertidal, and littoral areas*, are ideal areas to investigate linkages between human and natural components of the ecosystem because they are significant and critical points of intense socio-ecological interactions, and climate change.

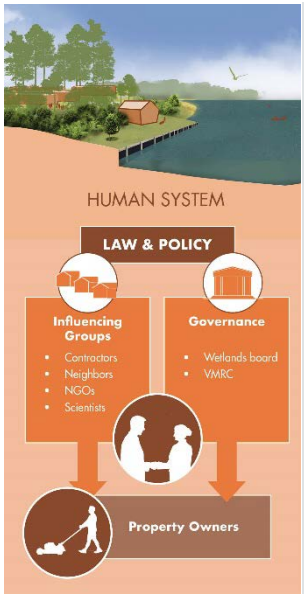
FINDINGS

Shoreline development and armoring reduces the resiliency of natural marshes under sea level rise, leading to decreased marsh habitat and ecosystem services.

The more sustainable and ecologically sound alternative, living shorelines (i.e. created tidal marsh), provide similar marsh habitat for most estuarine fauna and had similar plant productivity as reference marshes within 2 years, suggesting that many ecosystem services will be sustained if living shorelines are used as shore protection.

As the living shoreline marsh matures, sediments become richer and store more nutrients, and mussel abundance increases. These ecosystem services will be enhanced over time (years to decades).

Living shorelines in urban and rural settings performed similarly to nearby natural marshes indicating that created, living shoreline marshes provide valuable services in both urban and rural locations.



Property owner shoreline modification decisions are primarily influenced by marine contractors, neighbors, and nonprofit organizations. Direct training and engagement of key influencing groups could enhance living shoreline use and integration into local and social norms.

Armored shorelines are held to a lesser standard in the law than living shorelines, limiting living shoreline use. To manage for sustained ecosystem services, regulations should be updated to have a shorescape perspective that accommodate shifting marsh boundaries with sea level rise and reflect current societal concerns and values.

Revised policies, in concert with enhanced communication by influencing groups to property owners on the societal value of ecosystem services provided by marshes and living shorelines, will likely result in more sustainable shorelines and coastal communities under a changing climate.

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